MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

ECT2036 – CIRCUITS AND SIGNALS

(All sections / Groups)

12 OCTOBER 2016
2:30 am – 4:30 pm
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 8 pages including cover page with 4 Questions only.
2. Attempt **ALL** the questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers in the Answer Booklet provided.
4. Appendix is provided after the question pages.

Question 1

a) i. From your understanding of network graph terminology, draw a possible resistive circuit for the given graph in Figure Q1(a) if there are one current and voltage source each in the circuit. [7 marks]

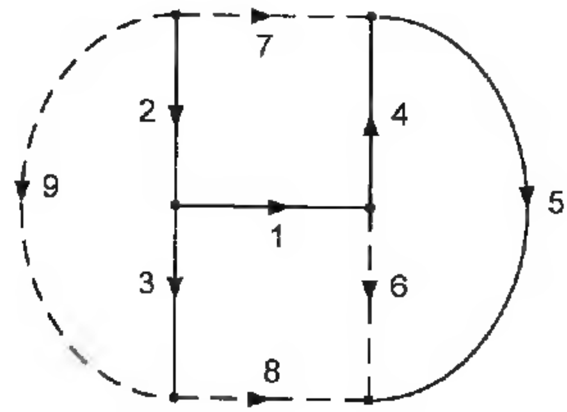

Figure Q1(a)

ii. List all the fundamental cutset from the graph in Figure Q1(a). [5 marks]

b) Use the energy formula to determine the energy of the signal described by
$f(t) = t^2\{u(t+1) - u(t-4)\}$ [7 marks]

c) Sketch the signal given by
$g(t) = t\{u(t+1) - u(t)\} + 2e^{-t}\{u(t) - u(t-2)\} + u(t-2)$ for $-2 \le t \le 4$

[6 marks]

Continued...

Question 2

a) Determine the inverse Laplace transform of $F(s) = \dfrac{8s + 30}{s^2 + 25}$ [4 marks]

b) The switch in Figure Q2 is initially closed for a long time.
At $t = 0$, the switch is opened. For $t > 0$,

i. draw the s-domain equivalent circuit. [4 marks]

ii. determine the current $i(t)$ and voltage drop across the 10Ω resistor. [8+6 marks]

iii. determine the capacitor voltage, v_C. [3 marks]

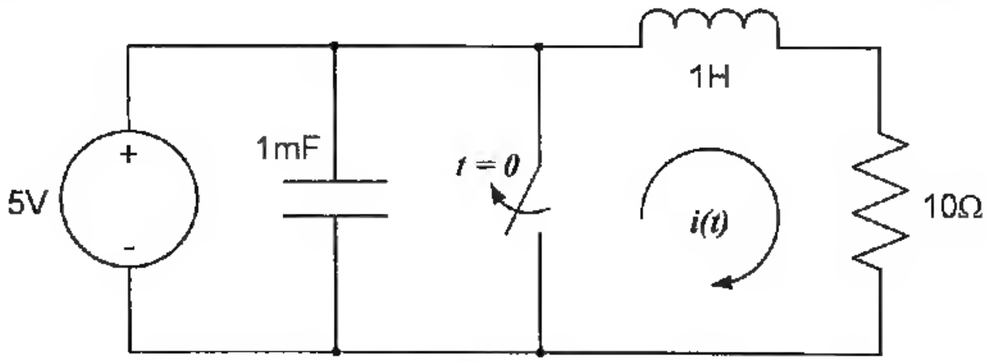

Figure Q2

Continued…

Question 3

a) Consider the two-port network in Figure Q3(a) below.

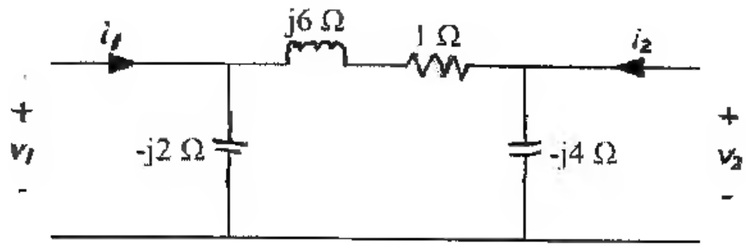

Figure Q3(a)

i. Determine the impedance parameters. [8 marks]
ii. Convert the impedance parameters to transmission parameters. [5 marks]

b) Consider the following circuit in Figure Q3(b) that has two input sources v_1 and v_2. Determine both the state and output equations if v_o and i_o are the output variables.

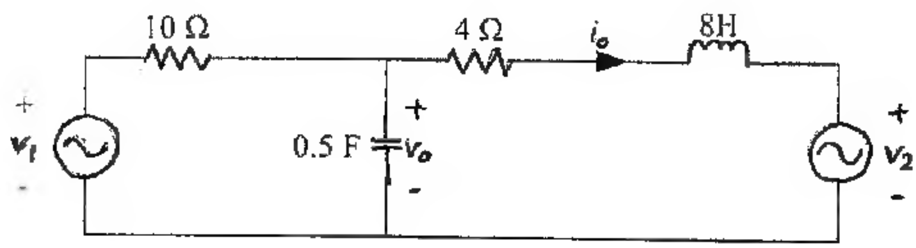

Figure Q3(b)

[12 marks]

Continued...

Question 4

a) Test whether the following polynomial is Hurwitz. [6 marks]

$$P(s) = s^4 + 5s^3 + 5s^2 + 4s + 3$$

b) Synthesize the following function using Cauer 1st Method [11 marks]

$$Z(s) = \frac{(s+4)(s+9)}{s(s+7)}$$

c) Given the following specifications of a Butterworth filter,

Maximum pass-band attenuation, $A_P = 1.5dB$
Minimum stop-band attenuation, $A_S = 80dB$
Maximum pass-band frequency, $f_p = 10kHz$
Minimum stop-band frequency, $f_s = 200kHz$

i. determine the filter order n. [5 marks]
ii. determine the cutoff frequency, f_c when it is satisfied in the pass-band. [3 marks]

APPENDIXES

Chapter 1:

Nodal Analysis	Mesh Analysis
1. $Y_N = AYA^T$	1. $Z_M = BZB^T$
2. $e_{\text{Node}} = -Y_N^{-1}A(I+YE)$	2. $i_{\text{Mesh}} = Z_M^{-1}B(E+ZI)$
3. $e = A^T e_{\text{Node}}$	3. $i = B^T i_{\text{Mesh}}$
4. $i = Ye + (I+YE)$	4. $e = Zi - (E+ZI)$
Fundamental Cutset Analysis	**Fundamental Loop Analysis**
1. $Y_C = CYC^T$	1. $Z_L = DZD^T$
2. $e_{\text{Twig}} = -Y_C^{-1}C(I+YE)$	2. $i_{\text{Link}} = Z_L^{-1}D(E+ZI)$
3. $e = C^T e_{\text{Twig}}$	3. $i = D^T i_{\text{Link}}$
4. $i = Ye + (I+YE)$	4. $e = Zi - (E+ZI)$

Chapter 2:

Even signal: $f(t) = f(-t)$ or $f[n] = f[-n]$

Odd signal: $f(t) = -f(-t)$ or $f[n] = -f[-n]$

Energy content: $E = \lim\limits_{T\to\infty} \int_{-T}^{T} f^2(t)dt$ or $E = \lim\limits_{N\to\infty} \sum_{n=-N}^{N-1} f^2[n]$

Power content: $P = \lim\limits_{T\to\infty} \frac{1}{2T} \int_{-T}^{T} f^2(t)dt$ or $P = \lim\limits_{N\to\infty} \frac{1}{2N} \sum_{n=-N}^{N-1} f^2[n]$

Chapter 3: Laplace transform pairs

No.	*t*-domain function	*s*-domain transform
1.	$\delta(t)$	1
2.	$u(t)$	$1/s$
3.	$tu(t)$	$1/s^2$
4.	t^n	$\frac{n!}{s^{n+1}}$
5.	e^{-kt}	$\frac{1}{s+k}$
6.	$t^n e^{-kt}$	$\frac{n!}{(s+k)^{n+1}}$

7.	$\sin\omega t$	$\frac{\omega}{s^2+\omega^2}$
8.	$\cos\omega t$	$\frac{s}{s^2+\omega^2}$
9.	$e^{-kt}\sin\omega t$	$\frac{\omega}{(s+k)^2+\omega^2}$
10.	$e^{-kt}\cos\omega t$	$\frac{s+k}{(s+k)^2+\omega^2}$
11.	$t\sin\omega t$	$\frac{2\omega s}{(s^2+\omega^2)^2}$

Chapter 4: Interrelation of parameters

	z	y	h	g	$ABCD$	$abcd$
z	$\begin{matrix} z_{11} & z_{12} \\ z_{21} & z_{22} \end{matrix}$	$\begin{matrix} \frac{y_{22}}{\Delta y} & \frac{-y_{12}}{\Delta y} \\ \frac{-y_{21}}{\Delta y} & \frac{y_{11}}{\Delta y} \end{matrix}$	$\begin{matrix} \frac{\Delta h}{h_{22}} & \frac{h_{12}}{h_{22}} \\ \frac{-h_{21}}{h_{22}} & \frac{1}{h_{22}} \end{matrix}$	$\begin{matrix} \frac{1}{g_{11}} & \frac{-g_{12}}{g_{11}} \\ \frac{g_{21}}{g_{11}} & \frac{\Delta g}{g_{11}} \end{matrix}$	$\begin{matrix} \frac{A}{C} & \frac{\Delta a}{C} \\ \frac{1}{C} & \frac{D}{C} \end{matrix}$	$\begin{matrix} \frac{d}{c} & \frac{1}{c} \\ \frac{\Delta b}{c} & \frac{a}{c} \end{matrix}$
y	$\begin{matrix} \frac{z_{22}}{\Delta z} & \frac{-z_{12}}{\Delta z} \\ \frac{-z_{21}}{\Delta z} & \frac{z_{11}}{\Delta z} \end{matrix}$	$\begin{matrix} y_{11} & y_{12} \\ y_{21} & y_{22} \end{matrix}$	$\begin{matrix} \frac{1}{h_{11}} & \frac{-h_{12}}{h_{11}} \\ \frac{h_{21}}{h_{11}} & \frac{\Delta h}{h_{11}} \end{matrix}$	$\begin{matrix} \frac{\Delta g}{g_{22}} & \frac{g_{12}}{g_{22}} \\ \frac{-g_{21}}{g_{22}} & \frac{1}{g_{22}} \end{matrix}$	$\begin{matrix} \frac{D}{B} & \frac{-\Delta a}{B} \\ \frac{-1}{B} & \frac{A}{B} \end{matrix}$	$\begin{matrix} \frac{a}{b} & \frac{-1}{b} \\ \frac{-\Delta b}{b} & \frac{d}{b} \end{matrix}$
h	$\begin{matrix} \frac{\Delta z}{z_{22}} & \frac{z_{12}}{z_{22}} \\ \frac{-z_{21}}{z_{22}} & \frac{1}{z_{22}} \end{matrix}$	$\begin{matrix} \frac{1}{y_{11}} & \frac{-y_{12}}{y_{11}} \\ \frac{y_{21}}{y_{11}} & \frac{\Delta y}{y_{11}} \end{matrix}$	$\begin{matrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{matrix}$	$\begin{matrix} \frac{g_{22}}{\Delta g} & \frac{-g_{12}}{\Delta g} \\ \frac{-g_{21}}{\Delta g} & \frac{g_{11}}{\Delta g} \end{matrix}$	$\begin{matrix} \frac{B}{D} & \frac{\Delta a}{D} \\ \frac{-1}{D} & \frac{C}{D} \end{matrix}$	$\begin{matrix} \frac{b}{a} & \frac{1}{a} \\ \frac{-\Delta b}{a} & \frac{c}{a} \end{matrix}$
g	$\begin{matrix} \frac{1}{z_{11}} & \frac{-z_{12}}{z_{11}} \\ \frac{z_{21}}{z_{11}} & \frac{\Delta z}{z_{11}} \end{matrix}$	$\begin{matrix} \frac{\Delta y}{y_{22}} & \frac{y_{12}}{y_{22}} \\ \frac{-y_{21}}{y_{22}} & \frac{1}{y_{22}} \end{matrix}$	$\begin{matrix} \frac{h_{22}}{\Delta h} & \frac{-h_{12}}{\Delta h} \\ \frac{-h_{21}}{\Delta h} & \frac{h_{11}}{\Delta h} \end{matrix}$	$\begin{matrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{matrix}$	$\begin{matrix} \frac{C}{A} & \frac{-\Delta a}{A} \\ \frac{1}{A} & \frac{B}{A} \end{matrix}$	$\begin{matrix} \frac{c}{d} & \frac{-1}{d} \\ \frac{\Delta b}{d} & \frac{b}{d} \end{matrix}$
A B C D	$\begin{matrix} \frac{z_{11}}{z_{21}} & \frac{\Delta z}{z_{21}} \\ \frac{1}{z_{21}} & \frac{z_{22}}{z_{21}} \end{matrix}$	$\begin{matrix} \frac{-y_{22}}{y_{21}} & \frac{-1}{y_{21}} \\ \frac{-\Delta y}{y_{21}} & \frac{-y_{11}}{y_{21}} \end{matrix}$	$\begin{matrix} \frac{-\Delta h}{h_{21}} & \frac{-h_{11}}{h_{21}} \\ \frac{-h_{22}}{h_{21}} & \frac{-1}{h_{21}} \end{matrix}$	$\begin{matrix} \frac{1}{g_{21}} & \frac{g_{22}}{g_{21}} \\ \frac{g_{11}}{g_{21}} & \frac{\Delta g}{g_{21}} \end{matrix}$	$\begin{matrix} A & B \\ C & D \end{matrix}$	$\begin{matrix} \frac{d}{\Delta b} & \frac{b}{\Delta b} \\ \frac{c}{\Delta b} & \frac{a}{\Delta b} \end{matrix}$
a b c d	$\begin{matrix} \frac{z_{22}}{z_{12}} & \frac{\Delta z}{z_{12}} \\ \frac{1}{z_{12}} & \frac{z_{11}}{z_{12}} \end{matrix}$	$\begin{matrix} \frac{-y_{11}}{y_{12}} & \frac{-1}{y_{12}} \\ \frac{-\Delta y}{y_{12}} & \frac{-y_{22}}{y_{12}} \end{matrix}$	$\begin{matrix} \frac{1}{h_{12}} & \frac{h_{11}}{h_{12}} \\ \frac{h_{22}}{h_{12}} & \frac{\Delta h}{h_{12}} \end{matrix}$	$\begin{matrix} \frac{-\Delta g}{g_{12}} & \frac{-g_{22}}{g_{12}} \\ \frac{-g_{11}}{g_{12}} & \frac{-1}{g_{12}} \end{matrix}$	$\begin{matrix} \frac{D}{\Delta a} & \frac{B}{\Delta a} \\ \frac{C}{\Delta a} & \frac{A}{\Delta a} \end{matrix}$	$\begin{matrix} a & b \\ c & d \end{matrix}$

$\Delta z = z_{11}z_{22} - z_{12}z_{21}$; $\Delta y = y_{11}y_{22} - y_{12}y_{21}$

$\Delta h = h_{11}h_{22} - h_{12}h_{21}$; $\Delta g = g_{11}g_{22} - g_{12}g_{21}$

$\Delta a = AD - BC$; $\Delta b = ad - bc$

Chapter 7: Polynomial functions of $C_n(\omega)$ of a low-pass Chebyshev filter

Order n	Polynomial $C_n(\omega)$
0	1
1	ω
2	$2\omega^2 - 1$
3	$4\omega^3 - 3\omega$
4	$8\omega^4 - 8\omega^2 + 1$
5	$16\omega^5 - 20\omega^3 + 5\omega$
6	$32\omega^6 - 48\omega^4 + 18\omega^2 - 1$
7	$64\omega^7 - 112\omega^5 + 56\omega^3 - 7\omega$

End of paper.